August 26, 2020

VIA ELECTRONIC FILING

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, DC 20554

Re: Ex Parte Presentation, *Expanding Flexible Use of the 3.7-4.2 GHz Band*, GN Docket No. 18-122

Dear Ms. Dortch:

CTIA submits the following response to the Study filed by the Aerospace Vehicle Systems Institute ("AVSI") on July 2, 2020 with regard to co-existence and interference risks between new 3.7 GHz Services and altimeter operations in the 4.2-4.4 GHz band.[1] The Study does not provide an adequate evidentiary basis for its alleged findings regarding interference, as described below. CTIA encourages stakeholders within the aviation community to provide sufficient data for any findings going forward, preferably within the multi-stakeholder Technical Working Group Sub-Group 3 ("TWG-3"), "5G/Aeronautical Coexistence," which is charged with considering these very issues.

The Air Ambulance Study examines interference from two terrestrial base station sources to two altimeter types at four heliport locations for a total of eight scenarios—and the Study reflects only one scenario of potential exceedance of the receiver overload threshold. The Study derives its conclusion based on this single scenario, but AVSI has previously excluded results from that altimeter type, and in any event AVSI fails to provide data necessary to demonstrate harmful interference. In particular:

- The single scenario of potential exceedance relies on an outlier device, Altimeter Type 7, which AVSI previously excluded from earlier test results due to anomalies.
- The interference tolerance threshold, or receiver overload level, for Altimeter Type 7 appears to be based on a "no computed data" (or "NCD") proprietary determination by

[1] *See* Aerospace Vehicle Systems Institute, *AFE 76s2 Report, Helicopter Air Ambulance RF Interference Scenario* (July 2, 2020) ("Air Ambulance Study" or "Study"), *attached to* Letter from David Redman, AVSI to Marlene H. Dortch, FCC, GN Docket No. 18-122 (filed July 2, 2020) ("July 2, 2020 AVSI *Ex Parte* Letter").

the device maker, not on any transparent performance metric. There is thus no way to independently ascertain *harmful* interference.

- Altimeter Type 7 performance does not exhibit behavior expected with a change in simulated altitude (*i.e.*, higher interference tolerance at lower elevations, due to stronger return signals), even though all other altimeters under the same scenarios appear to behave as expected. This could be an indication that Altimeter Type 7 may not have been operating properly during testing.
- AVSI's use of aggregated test results in earlier measurement reports does not permit the independent assessment of individual altimeter performance and therefore cannot support a finding of harmful interference. In this instance, AVSI discusses performance of Altimeter Type 6 and references a threshold not shared in prior reports.

For the reasons discussed below, CTIA urges the Commission to dismiss the findings contained within the Air Ambulance Study and encourages all stakeholders to engage in robust dialogue in TWG-3.

The *3.7 GHz Report and Order* and Technical Working Group-3. As an initial matter, it is important to highlight the Commission's analysis in the *3.7 GHz Report and Order* and its conclusion that the 3.7 GHz Service power and emission limit rules and the spectral separation of 220 megahertz "are sufficient to protect aeronautical services in the 4.2-4.4 GHz band."[2] The Commission was also clear on next steps. First, while recognizing the ability of the services to coexist, the Commission agreed with AVSI that further analysis is warranted even though "well-designed equipment should not ordinarily receive any significant interference (let alone harmful interference)" given the circumstances above.[3] The Commission encouraged the aviation community to participate in the Technical Working Group arising out of the *3.7 GHz Report and Order*. Second, the Commission directed the aviation community to resolve any issues as necessary: "[w]e expect the aviation industry to take account of the RF environment that is evolving below the 3980 MHz band edge and take appropriate action, if necessary, to ensure protection of such devices."[4]

AVSI asserts that the Air Ambulance Study "is provided to the Commission to assist it with ongoing work,"[5] but to be clear, AVSI did not share the Study with the TWG-3. Stakeholders from a

[2] *3.7 GHz Report and Order* ¶ 395.

[3] *Id*.

[4] *Id*.

[5] July 2, 2020 AVSI *Ex Parte* Letter at 1.

variety of industries and companies established a multi-stakeholder group, including TWG-3, soon after the *3.7 GHz Report and Order* was adopted, and TWG-3 is co-chaired by representatives from CTIA and the Aerospace Industries Association.[6] CTIA and the wireless industry are working in good faith within TWG-3 but respond to the Air Ambulance Study here given that it was filed in the public record.

Basics of the Air Ambulance Study. The Study builds on analysis conducted in two earlier reports on radio altimeters and out-of-band interference prepared by AVSI,[7] and it assesses four heliport locations at the Texas Medical Center, captured in the Study's Table 1 and reproduced below:

Table 1: Heliport Characteristics

#	Hospital Name	FAA ID	Latitude	Longitude	Elevation (MSL)	Height (AGL)
1	Memorial Hermann	38TE	29° 42' 48" N	95° 23' 41" W	303 ft	255 ft
2	Houston Methodist	TX86	29° 42' 38" N	95° 23' 55" W	445 ft	400 ft
3	Baylor St. Luke's	64TS	29° 42' 28" N	95° 23' 57" W	165 ft	120 ft
4	Texas Children's	7XS2	29° 42' 29" N	95° 24' 10" W	427 ft	385 ft

[6] As part of the TWG-3 effort, the aviation stakeholders and 3.7 GHz Service stakeholders developed and provided to each other numerous questions and responses regarding 5G technical characteristics that would successfully define a generic 5G environment and altimeter technical characteristics that would successfully define a generic radio altimeter. The TWG-3 members agreed that use of any information exchanged would not reflect any judgments or support with respect to the findings in the analysis and that all reports developed based on the exchanged information would be presented to TWG-3.

[7] *AFE 76s2 Report, Preliminary Report: Behavior of Radio Altimeters Subject to Out-of-Band Interference*, Aerospace Vehicle Systems Institute, at 15 (Oct. 22, 2019) ("Oct. 22, 2019 Preliminary Report"), *attached to* Letter from David Redman, AVSI to Marlene H. Dortch, FCC, GN Docket No. 18-122 (filed Oct. 19, 2019); *AFE 76s2 Report, Effect of Out-of-Band Interference Signals on Radio Altimeters, Supplement to Preliminary Report dated 22 October 2019*, Aerospace Vehicle Systems Institute, at 10 (Feb. 4, 2020) ("Feb. 4, 2020 Supplemental Report"), *attached to* Letter from David Redman, AVSI to Marlene H. Dortch, FCC, GN Docket No. 18-122 (filed Feb. 4, 2020).

The Study noted two base stations in relatively close proximity to the heliports, identified in the Study's Table 2 and reproduced below:

Table 2: LTE Base Station Characteristics

FCC Registration	Latitude	Longitude	Elevation (MSL)	Height (AGL)
1273628	29° 42' 26" N	95° 23' 42" W	155 ft	110 ft
1273626	29° 42' 37" N	95° 23' 58" W	271 ft	225 ft

The Study determined the likely flight paths for each heliport and calculated the resulting 5G signal level at the helicopter altimeter receiver port (power spectral density or PSD) along each flight path, based on the 3.7 GHz Service maximum power levels adopted by the Commission in the *3.7 GHz Report and Order*. The Study focused on the two altimeter types typically used in helicopters, Altimeter Type 6 and Type 7, and identified interference tolerance thresholds (or receiver overload thresholds) for each of the altimeter types. AVSI based its determination of harmful interference on the occurrence of any one of three different metrics: 1) a mean height error greater than 0.5%; 2) fewer than 98% of all data points in the RF power on interval fall within the ±2% limits specified by ARINC 707; or 3) any height reading that reported NCD, a proprietary determination.[8]

The strongest interfering signal, occurring at the closest approach to each base station, was captured in the Study's Table 4, and reproduced below:

Table 4: Maximum PSD Relative to Interference Tolerance Threshold for Type 6 & 7 Altimeters

#	Hospital Name	Max PSD_i from BS #1	Max PSD_i from BS #2	P_{ITT} Type 6 Altimeter	P_{ITT} Type 7 Altimeter	Units
1	Memorial Hermann	-67	-61.3	-20	-47	dBm/MHz
2	Houston Methodist	-62	-40	-20	**-47**	dBm/MHz
3	Baylor St. Luke's	-57	-56.5	-20	-47	dBm/MHz
4	Texas Children's	-67.2	-62.5	-20	-47	dBm/MHz

The closest base station to a heliport was Base Station 2, with a horizontal distance of 164 ft. The heliport at Houston Methodist stands higher above ground than the base station by (445-271) = 174

[8] *See* Oct. 22, 2019 Preliminary Report at 15.

ft, as illustrated in the photo below. The vertical angle from the base station to the heliport is 46.7 degrees, and the slant distance is 239 ft (73 m).

The only potential exceedance reported by AVSI was for outlier Altimeter Type 7 at Houston Methodist, with a maximum PSD from Base Station 2 of -40 dBm/MHz and an interference tolerance threshold of -47 dBm/MHz. Notably, Altimeter Type 6 has a 20 dB margin relative to the 5G signal level from Base Station 2 at the Houston Methodist heliport.

Altimeter Type 7: Outlier Results. The Air Ambulance Study reaches its conclusions regarding interference based on the performance of the outlier Altimeter Type 7—"a significantly lower cost altimeter"[9]—but it is critical to note that AVSI has already called into question reliance on Altimeter Type 7 results. In AVSI's Supplemental Report filed in February 2020, AVSI observed:

> Altimeter Type 7 exhibited a reduced [out-of-band interference] tolerance threshold compared to the other six [radio altimeters] tested, generally in the range of -30 to -27 dBm across the full 3700-4200 MHz band, with little to no frequency dependence. *As such, the data from this altimeter was excluded from the combined [interference tolerance mask] plots*…[10]

[9] *Id*. at 21.

[10] Feb. 4, 2020 Supplemental Report at 10 (emphasis added).

Yet here, without explanation, AVSI accepts the results of Altimeter Type 7 and relies exclusively on them for its determination about harmful interference. This, in and of itself, calls into question the findings from the Air Ambulance Study.

AVSI's test results show Altimeter Type 7 is an outlier device. AVSI's Preliminary Report submitted in October 2019 contained data in Figure 10 and Figure 11 reproduced below that show test results for the worst of Altimeters Types 1-6 and a separate figure for Type 7.[11] We add the red boxes to highlight and compare performance for a 100 megahertz-wide interfering signal operating at 3800 MHz. The worst altimeter of Types 1-6 performs more than 20 dB better than Type 7.

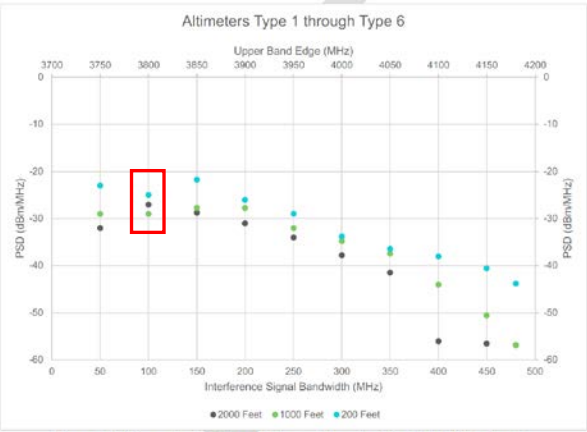

Figure 10: Minimum Break Points of Altimeter Types 1 – 6 for Each Altitude Tested.

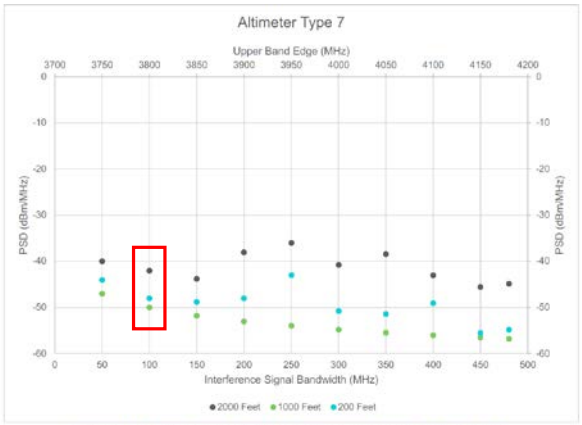

Figure 11: Minimum Break Points of Altimeter Type 7 for Each Altitude Tested.

Additionally, the data AVSI presents identifies an interference tolerance threshold of -47 dBm/MHz for Altimeter Type 7, and here that threshold appears to have been triggered only by a NCD flag. AVSI describes NCD as a situation whereby "unreliable altitude readings are output on the 429 bus along with an error flag that indicates No Computed Data (NCD)."[12] This flag is proprietary to the altimeter vendor and reveals no performance criteria whatsoever. As AVSI observes, "[c]riteria for reporting NCD can vary with the specific signal processing design in the various altimeters, but it is generally indicative of a condition in which the signal-to-noise ratio of the received [frequency modulated continuous wave] signal is insufficient to compute an altitude with the required level of confidence."[13] AVSI's Preliminary Report submitted in October 2019 contained a Figure 7 reproduced

[11] These figures are from AVSI's October 2019 filing. *See* Oct. 22, 2019 Preliminary Report at 19-20.

[12] *Id*. at 11.

[13] *Id*.

below that indicates that the Altimeter Type 7 interference determination is always based on the NCD condition.[14]

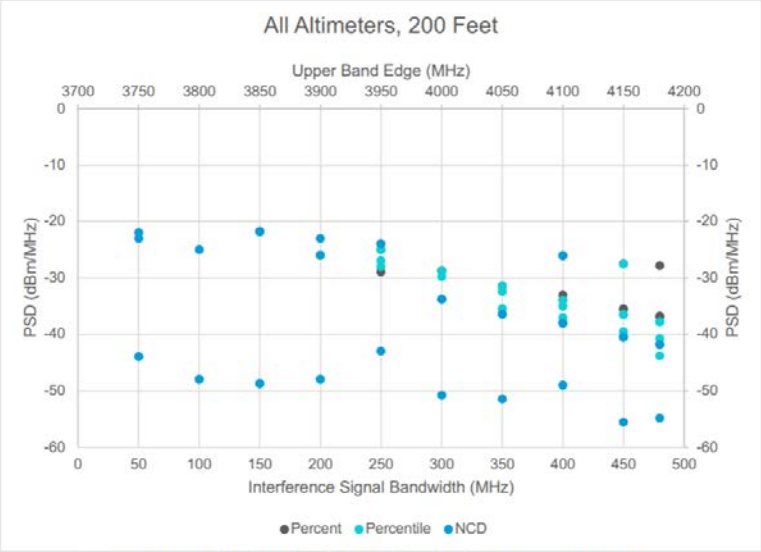

Figure 7: Aggregate Plot of Altimeter Break Points, 200 Feet.

AVSI does not provide any indication as to the actual altitude determinations, only that the altimeter made a proprietary determination that the altitude is "unreliable."

Further, Altimeter Type 7 showed additional anomalous results as compared to the other six altimeters AVSI measured in the area of receiver resiliency versus altitude. The Altimeter Types 1-6 chart above shows the best performance at the 200 feet altitude level, and has increasing susceptibility as a function of altitude, with 2000 feet being the most sensitive to interference. Outlier Altimeter Type 7's results are anomalous and not at all predictable—the 2000 feet altitude shows the least impact, with 200 feet next, and 1000 feet being the most susceptible to interference. This could be an indication that Altimeter Type 7 may not have been operating properly during testing.

Although earlier AVSI filings recognized the irregularities associated with Altimeter Type 7 and concluded that "more work may be needed to properly catalogue the performance of these types of altimeters,"[15] there is no evidence that AVSI has performed any additional work on Altimeter Type 7 for the Air Ambulance Study. Indeed, AVSI ignores its earlier concerns in the Air Ambulance Study. Whereas AVSI excluded results from Altimeter Type 7 given its anomalies, it now relies exclusively on Altimeter

[14] *Id*. at 16.

[15] *Id*. at 21.

Type 7 results for its findings. No conclusions can be drawn from a study that shows only a single case of interference involving an altimeter that exhibited anomalous operations and was excluded from prior analysis as a result.

Altimeter Type 6: Obscured Results. In its earlier measurement reports, AVSI uses a composite "envelope" of aggregated data sets for Altimeter Types 1 through 6 by showing only the minimum measured interference threshold across the group of altimeters.[16] But use of this type of envelope approach obscures the frequency selective behavior of each individual altimeter, rendering the interference analysis inaccurate. As such, the derivation of the individual interference tolerance threshold for Altimeter 6 at -20 dBm/MHz, as referenced in the Study, is questionable.[17] While the results reported by AVSI for Altimeter Type 6 show interference levels to be 20 dB below the interference threshold, the interference tolerance threshold for Altimeter Type 6 to specific measurement results cannot be derived from the earlier AVSI measurements. Because the data used to create the interference thresholds for Altimeter Type 6 was aggregated with threshold data for five additional altimeter types, it is not possible to conclude that the threshold used in these calculations actually corresponds to the performance of Altimeter Type 6.

Further, Figure 7 from AVSI's Preliminary Report submitted in October 2019 does not provide any delineation as to individual altimeter performance, thus the only information that can be obtained from Figure 7 and applied for an individual altimeter is the outlier Altimeter Type 7. The variations in individual altimeter performance are essential to ensure the studies assess real-world situations, and are not focused on the worst of several specifications that would never be deployed together in practice. A robust analysis would require individual empirical altimeter performance data both in terms of its receiver overload thresholds and its filter rejection.

AVSI shows a representative "Power Sweep Plot" that would presumably show the altitude measurements,[18] along with the NCD indicators, but AVSI does not provide this information for each of the altimeters studied. Thus, there is no way to determine if the altimeter is actually computing an altitude within the specified accuracy range, but flagging the data as unreliable for unknown reasons, or if the altimeter is truly reporting faulty altitude data (or no altitude data).

[16] *See id*. at 19.

[17] *See* Air Ambulance Study at 10.

[18] *See* Oct. 22, 2019 Preliminary Report at 12.

Further Considerations. Finally, the Air Ambulance Study does not account for other factors that would be relevant to any assessment of interference in the heliport circumstances at issue here.

First, the Air Ambulance Study uses measured interference tolerance thresholds as reported in its October 2019 Report,[19] but the earlier AVSI measurements determined altimeter performance at 200 feet altitude applying an airport-centric configuration, with the presence of a number of other operating altimeters, representing a worst-case landing scenario ("WCLS"). The WCLS considered 14 other altimeters in proximity to the unit under test, based on four nearby airplanes each with three altimeters installed, and a fifth airplane with a dual-altimeter configuration.[20] This airport approach should not apply to a heliport configuration, which likely supports far fewer simultaneous helicopters, with each helicopter equipped with just a single altimeter. However, because the 200 foot altitude data was only measured with the additional interference sources artificially injected into the altimeter receiver, it is not possible to determine the impact of the base station signal in the absence of multiple aircraft, each with multiple altimeters transmitting simultaneously. In fact, some of the altimeters tested were not able to operate in the original test configuration due to this self-interference that AVSI injected into the test scenario, which AVSI states is "not a part of standard test configurations in accordance with the [Minimum Operational Performance Standards]."[21]

And second, as part of TWG-3, 3.7 GHz Service stakeholders and the aviation community have been sharing information regarding their respective operations. In mid-July, the aviation community provided information that characterizes typical altimeter antenna performance in terms of reductions in antenna gain for frequencies received below the 4.2-4.4 GHz radio altimeter band, and reductions in antenna gain that occur when the signal source is outside of the mainbeam of the altimeter antenna. There is no evidence that AVSI has accounted for these fundamental aspects of what should be included in the interference analysis.

[19] *See* Air Ambulance Study at 10.

[20] *See* Oct. 22, 2019 Preliminary Report at 9.

[21] *Id*. at 14.

* * *

CTIA appreciates the ongoing work by all stakeholders within TWG-3, and we encourage continued good faith efforts to address 5G/altimeter co-existence within that body.

Sincerely,

/s/ Doug Hyslop
Doug Hyslop
Vice President, Technology and Spectrum Planning

Kara Graves
Assistant Vice President, Regulatory Affairs